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ABSTRACT

Because large scale individualized learning systems place excessive demands on conventional means of producing audiovisual software, electronic image generation has been investigated as an alternative. A prototype, experimental device, Scanimate-500, was designed and built by the Computer Image Corporation. It uses photographic, television, and computer electronic technology to produce 35mm slides. Results of a 60-day evaluation showed that image generation proved viable for certain slide categories, perhaps 15% of total graphic requirements. A broader, continued research effort is in progress to perfect this technological approach. (EMH)

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# AIR FORCE HUMAN RESOURCES LABORATORY



INVESTIGATION OF ELECTRONIC GENERATION OF VISUAL IMAGES FOR AIR FORCE TECHNICAL TRAINING

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This technical report has been reviewed and is approved.

MARTY R. ROCKWAY, Technical Director
Technical Training Division

Approved for publication.

HAROLD E. FISCHER, Colonel, USAF
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# SUMMARY


## Problem

Air Force implementation of individualized, self-paced technical training programs has created a marked increase in the requirements for instructional visuals such that conventional approaches to audiovisual courseware preparation are no longer adequate to fully satisfy current needs. There is a critical requirement to develop more cost-effective techniques for meeting the growing demands for increased quantities and faster turn around times for instructional visuals in order to fully exploit the full capabilities of mediated instructional technology in Air Force training.

## Approach

Recent introductions of electronic image generators presented the possibility that electronic technology might assist in increasing production while decreasing reliance on labor intensive, flat, art-cards. After surveying a variety of approaches to electronic image generation, the Scanimate-500 designed by the Computer Image Corporation, Denver, Colorado, was selected to explore the potential of the technique. This prototype experimental device allows for illustrator-controlled sizing, positioning, colorizing, posterization and reconfiguration. Material could be input as filmstrip, 35mm slide, or flat copy (pictorial or narrative), output consisted of 35mm slides. Towards the end of a one-year investigation, the device was placed in an operational environment for a 60-day evaluation. This report covers that evaluation.

## Results

Although the limitations of this study precluded an exhaustive evaluation, it appears that certain categories of 35mm slides could be produced cost-effectively. For example, graphics involving progressive disclosure or iterative treatment (as in subject familiarization sequences) were particularly suited to the approach. Illustrators were able to master system operations. The ability to manipulate input material in design sessions without resorting to paper and pencil was a significant advantage.

## Conclusions

Electronic image generation is still a new and developing technology. While the 60-day evaluation appeared to prove the approach viable, more research is indicated. Refinement of procedures coupled with a wider-ranged program would do much to solidify the methodology. It is conceivable that as high as 15% of a total visual requirement could be handled electronically. Further investigations might well determine additional usage.

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# INVESTIGATION OF ELECTRONIC GENERATION OF VISUAL IMAGES FOR AIR FORCE TECHNICAL TRAINING

## I. INTRODUCTION

One of the major problems in the development of media-based instructional systems is to find cost-effective, more expedient means to keep media software development abreast of increasing instructional demands. Such demands are overburdening existing production facilities to the extent that further advances in the development and use of heavily mediated instructional systems is seriously hampered. Conventional approaches to audiovisual software preparation are no longer sufficient to meet current, much less future, needs.

With the installation of learning centers within various Air Force training situations, and especially with the initiation of such major projects as the Advanced Instructional System (AIS), comes a demand for major increases in the requirements for mediated software. Of particular importance is the massive requirement for visual portions of prenarrated learning sequences. It is anticipated, for example, that the installation of a learning center at a USAF Technical Training Center will increase the requirement for slides, or their equivalent, by a factor of 100.

One of the constraints blocking further development of mediated instructional sequences is the difficulty encountered in the rapid generation of quality graphic materials. The problem is compounded when changes or revisions are made necessary to existing instructional software due to everchanging instructional content.

A major limitation at present is in the continued utilization of conventional techniques that require an average of three man-hours for the production of a sophisticated title graphic and an average of forty man-hours for the rendering of a detailed electronic schematic. Rapid development of mediated instructional segments is being unnecessarily hampered due to these time-consuming, costly procedures. Additional graphic arts personnel serve only a stopgap function and do not insure meeting future, increased, demand. The problem is not in the number of individuals performing the task; it is in the methodology of the task performance.

One possible answer is a device which blends the advantages and procedures of the graphic arts, photography, television, and computer electronics. Properly integrated under the control of a graphic artist, computer electronics could be used to add color, enhance visual characteristics, alter basic configurations and increase the instructional potential of imagery such that a few relatively crude illustrations could be transformed efficiently into a complex instructional sequence.

Such a device would also provide an opportunity to develop techniques that are presently possible only by time-consuming, labor-intense methods. A survey of state-of-the-art devices indicated either simple colorizing machines with no options for reconfiguration, or computerized graphics machines which lacked random and/or controllable color assignment.

One of the devices surveyed which featured all desirable options was the Scanimate 1000, developed by the Computer Image Corporation, Denver, Colorado. The model 1000, however, was designed for delivery of either video or 16mm motion picture film as a final product. Minor modification to the basic Scanimate elements resulted in the model 500-A, a prototype experimental electronic image generator, which was configured for the still image required for slide-filmstrip presentations.

The static picture was desired in that technical training deals more often with instructional, rather than actual, demonstration speed. At instructional speed, complex steps or procedures are reduced to single, discrete elements which constitute a given function. These single discrete steps are often handled as individual 35mm slides or filmstrip frames.

The 500-A was delivered to Technical Training Division, Air Force Human Resources Laboratory, Lowry Air Force Base, Colorado, (AFHRL/TT), where for approximately one year it was used for initial investigations. A good portion of this time was spent in contractor-conducted training of Laboratory, Air Training Command, and other personnel. The objective was to explore the techniques of utilizing electronic processing equipment to generate graphic materials for use in mediated training packages.

The 500-A was not procured as a production system as it was a prototype device not suited for direct incorporation into production atmospheres. It did, however, provide an opportunity to investigate feasibility of the technical approach.

After initial investigations with the 500-A, it was modified to a model-B configuration (see Figure 1). The primary difference was that actual photography took place at a 1000 line scan, high resolution monitor through a series of colored gels instead of at a standard 525 line scan color television monitor.

During the initial investigation period, a 60-day evaluation was conducted using the device to help assess the potential of the approach in a production atmosphere. This report documents only this 60-day period. A final report will be issued at a later date with a more thorough discussion of the overall investigation.

## II. APPROACH

During the conduct of the evaluation, the device was located in the Training Services Division of the United States Air Force School of Applied Aerospace Sciences, Lowry Air Force Base, Colorado. The move to the base software production facility was taken to maximize production level exposure.

Active Air Training Command projects, Air Force Systems Command projects, and materials being developed by the McDonnell Douglas Corporation for the Advanced Instructional System (AIS) were submitted for the test. No attempt was made to select or preselect programs. It was understood that every effort would be made to accomplish as many slides as possible using the Scanimate device. A total of eight programs was submitted and accomplished during the 60-day period.

Computer Image Corporation supplied a fully qualified engineer for scheduled shooting sessions and the Air Training Command provided individual project illustrators who were to work with the chief illustrator/operator. It was decided prior to the investigation that no attempts would be made to provide Scanimate training to individual project illustrators. AFHRL/TT had by this time trained their own operator who filled the chief illustrator/operator position and manipulated all Scanimate controls.

Where possible, selected projects were accomplished conventionally for comparative results. For the most part, graphic time estimates were computed based on known, similar job statistics maintained by the Training Services Division. Individual project illustrators were expected to prepare all input material after consultation with the chief illustrator/operator and art director from the Computer Image Corporation.

The evaluation began 6 August 1974 and ran for 60 calendar days through 4 October 1974.

## III. METHODOLOGY

All eight projects were accomplished on the Scanimate 500-B configuration and utilized Kodalith masters containing the desired verbalizations. These messages were superimposed for the most part over 35mm background slides or filmstrip frames, or, the background was electronically created. Three briefings consisting solely of verbalizations were completed on the Scanimate in their entirety.

The remaining projects were accomplished on Scanimate in part. These decisions were based on team evaluation that electronic processing was not required, simpler methods of accomplishment existed, or live photography (i.e., on-site photography) was required which did not need electronic enrichment. In all cases, these exceptions were handled via traditional methods.

The usual procedure to produce a 35mm slide required that verbal input be typed in the required format on an IBM Selectric or equivalent type setting device. This was then photographed and converted to Kodalith masters (Eastman Kodak Ortho Film 6556, Type 3). These masters, as a double frame 35mm filmstrip, were placed in one of two video camera stands. A suitable background contained on 35mm slide, filmstrip, or color print was placed on the second video camera stand.

This input material was fed into the system via television methodology, the operator then proceeded to electronically divide the input within the television raster via a dedicated computer processing unit

*Figure 1.* Mr. Edwin W. Ethem, Chief, Training Services Division (ATC), left, and Mr. Paul W. Hall, AFHRL/TT, at Scanimate 500-B.

(Analog). Sizing, location, and color assignment were then made as required or desired. Portions of the message unit not required were removed electronically.

In essence, the foreground and the background were electronically combined to form the required visual. Each could be manipulated separately. Once this initial composition was formed to the satisfaction of the user, action moved to the high resolution monitor where critical final adjustment took place. A Nikon F2 camera was located in front of the high resolution monitor to record the final image. Adjustments here were highly precise and did not necessarily match the picture displayed on the standard color monitor. Via a series of colored gels which mechanically fell into place, a 35mm photograph was taken using Eastman-Kodak Ektachrome-X film.

Set-up and initial checkout procedures were extensive and critical. The various equipment item locations often made for difficult human operations. The disparity between the high resolution and color viewing monitors was often confusing.

During all productions, color rendering appeared to be an imprecise operation. Several rolls of film returned from processing were clearly not the color calibrated on the device by the operator at the time of exposure. Color assignment was based on the gels in front of the camera and the color select switch positions on the color processing unit. This became somewhat disconcerting when operators tried to match previously produced colors or renderings as one might find in the revision of materials. Those projects accomplished in one session had greater chance of success.

It is difficult to establish time data in that the Scanimate provides virtually unlimited experimentation. These set-up procedures varied greatly in time. Each iteration was a "completed graphic" ready for shooting, the same occurrence is hardly possible in conventional accomplishment. The only time that remained constant is actual photography time of 20 seconds per slide (necessitated by the various gels; each shot is essentially photographed three times).

Of the eight projects completed, the fastest in time to produce averaged 6 minutes per slide. This was a routine briefing without sophisticated backgrounds. The most lengthy (i.e., difficult to produce) averaged 16 minutes per slide. Indicated times include set-up and actual photography.

These figures represent significant time savings when compared to the Air Training Command estimate of 3 ½ hours average for a similar graphic using conventional preparation methods. These "front end" time comparisons are more meaningful in that after the point of photography, the process is the same and time and cost figures are equal.

These figures should not be viewed as replicative in that projects differ greatly and the complexity of a given slide will dictate input preparation, set-up procedures, and electronic arrangement. In very few instances, however, would the total preparation time exceed the 3 ½ hour conventional statistic. Preparation of appropriate background materials, if they were required, should be added to total preparation time, as should typing of verbal message units. Again, tremendous variance may be experienced depending on methodology.

The 6 minute average statistic was for an elementary electronic rendition; the background was a series of colors which was electronically added. Typing time of the 23 slide units was 1 hour. This amounts to approximately 10 minutes total time for preparation and electronic processing for each slide.

Graphics or final slides which required simple superimposure of verbal message units over existing or electronically created backgrounds were easiest to accomplish. Multiple packages; i.e., an "n" of possible renditions from a single input such as one would expect from an electronic schematic, also made good use of the Scanimate 500.

## IV. DISCUSSION

Prior to any discussion of findings and recommendations, several facts should be reiterated. The Scanimate-500 electronic image generator was acquired as a prototype experimental tool within a research effort. The 60 day evaluation climaxed a one year investigation and training period.

In general it appears that much more research is needed. Electronic image generation is not only a relatively new technology, but the Scanimate is itself a prototype device. The A model of the device evolved quite naturally into the B model during the course of investigation and it would seem to follow that a C version may have evolved if pursued further.

It must also be stated that alternate methodologies exist for producing most of the materials used in the evaluation. Superimpositions of key instructional phrases or identifiers over a live background is possible via overlays or simple photographic operations.

A production atmosphere requiring a high volume of certain categories of 35mm slides would approach cost effective utilization of electronic image generation. Three of the sample projects were accomplished electronically in their entirety–these being briefings with no live photography requirements. Mediated technical training modules, however, tend to hold a proportionally higher number of live photographs or live photography requirements (approximately 60% live photography to 40% narrative or graphic material).

The use of an illustrator as chief operator proved to be a viable concept. It was possible for an illustrator with no previous electronic knowledges to master the required procedures. Few illustrators, for example, would have reason to include procedures for establishing a one volt peak-to-peak oscilloscope registration within their normal repetoire. During initial training sessions conducted by the contractor, representatives from AFHRL/TT, Air Training Command and McDonnell Douglas Corporation (prime contractor for the AIS) were able to grasp fundamental procedures necessary to produce a quality product.

The obvious advantages–indeed one of the tenets of the investigation–was that the illustrator was free to exercise considerable artistic license. As operator, he was able to make the technology serve his exact requirements. During the 60-day evaluation, dependence on the chief illustrator was maximized; no attempt was made to train ATC illustrators as operators.

This fact was responsible for bringing to light a considerable number of adaptive procedures–procedures which were often viewed by illustrators not familiar with system operations as unduly restrictive. They did not understand why input had to be structured in a certain fashion, or what was necessary to attain certain special effects. These same people were able to sit down with the chief illustrator/operator and view the various design iterations possible from a single input. Over time, it is possible for non-operators, by viewing the shooting screen, to understand input requirements.

It is not uncommon in traditional production methodologies, despite guidance to the contrary, to find a single 35mm slide with 12 or 13 lines of information. In that the Scanimate deals primarily with television technology, there is a physical limit to the resolution possible. This fact quickly becomes apparent when trying to accommodate an excess of information. Illustrators familiar with viewgraphs, where information excesses are rampant, often carry this exessiveness to other mediums. A lot could be learned from the advertising profession which attempts to extract the most mileage from the least verbiage.

An illustrator/operator who is aware of system requirements is in the best possible position to maximize electronic generation capabilities. In effect, a production atmosphere will soon create a "new breed" of illustrator comfortable in both roles.

One thing operators could not do during the initial year investigation or during the 60-day evaluation was troubleshoot. As a complex prototype device, the Scanimate was subject to the usual prototype failures. As a consequence, an electronic engineer was present for every production scheduled during the 60-day test so that downtime would not significantly interfere with production statistics.

While the 60-day evaluation did not seek to compare the A and B configurations exclusively, some observations can still be drawn based on earlier experiences. Although the B-configuration offers significant advantages in both product and process, the A-configuration was adequate for most tasks.

B-configuration operations detracted from an operators' ability to explore graphic possibilities with naive personnel. In that actual 35mm photography was accomplished at the high resolution monitor via a colored lens system, only the operator was privy to actual procedures. The picture displayed on the color monitor (actually used for shooting with A-configuration operations) was not necessarily a true representation of the picture displayed on the high resolution monitor. In a sense, B-configuration operations "trapped" the operator at the high resolution monitor, while A-operations invited all present to share in the determination of final form.

Re-creation of earlier renditions—especially color—were difficult. A briefing of 26 slides, for example, if accomplished in one setting, would be of equal color rendering. An overnight break would invariably lead to a new color background. This new background would be similar but seldom exactly equal in tone to the previous day's batch. Revisions of previously produced materials were sometimes obvious by their color difference.

The B-configuration also allowed for use of a suitable background over which lettering or pictorial emphasis could be placed. This proved to be a valuable option—especially in those instances requiring a progressive disclosure sequence. It was possible, for example, to place a standard explosive shell on the background camera over which movable parts could be randomly moved into place. Hence, it was possible to extract a multitude of slides from two pieces of input artwork.

Both A and B configurations provided myriad possibilities and all functions performed well (i.e., electronic sizing, repositioning, colorizing, etc.). Quality 35mm slides were produced with both configurations. A-configuration slides, however, being shot on a 525 raster line screen tend not to hold at great projection distances. They are, however, acceptable for carrel screen use and work well at shorter viewing distances.

## V. RECOMMENDATIONS

A greater attention to human factors placement of vital system components would make day-to-day operation of the Scanimate 500-B more operator-oriented. The location of a second monitor, for example, near the high resolution monitor would obviate current problems trying to adjust between the two monitors during set-up procedures.

Several members of the Lowry Training Services Division felt that the addition of an alphanumeric symbol generator would provide a more convenient method of superimposing verbal information over training backgrounds. The requirement to transfer all typed input to film masters, as input, was viewed as an unnecessary and undesirable step.

The addition of remote controls for the video cameras would make positioning and repositioning tasks easier. Current provisions require manual operations which, over time, become cumbersome.

Rewiring and reconfiguration of the many sizing and shaping controls to fewer elements would also make for easier operation. It is also suspected that this rewiring might increase system reliability. In that the Scanimate was a prototype device, it was expected that more than anticipated downtime would be experienced. The increased sophistication of the B-configuration equipment items registered more downtime than A-configuration equipment items.

A new photographic shield system (a light-tight box over the 35mm camera) which would either slide or fall into place would have its advantages. The existing, hand-removable, shield box proved clumsy.

Clearly, the 60-day evaluation raised some new questions. Additional inquiry into type sizes and fonts, an electronic image input style manual, and procedures investigations are all suggested.

The greatest benefits remain in the visualization of the end product and in the iterative investigation of the visual possibilities without having to resort to finished product. Those projects which consisted primarily of verbalization were handled expeditiously and more creatively than via conventional or traditional methodologies. It is conceivable that as high as 15 percent of total graphic requirements might be handled via this method. Further investigations of this methodology might very well determine increased use.

The Scanimate 500-B is still very much a research tool with a methodology still largely undefined. Extrapolating on the 60-day evaluation, it can be said that such technology would be advantageous for certain categories of slides of graphic materials and that the final products were unique and highly acceptable. There is, however, the constant knowledge that existing methodologies in photography or graphic arts may accomplish similar feats.

The Scanimate also makes demonstration in the graphic and visual arts an exciting possibility. The ability to reconfigure any given input, to colorize, to place, to size presents an instructional climate hitherto unknown. The use of Scanimate to produce training materials for the graphic or visual arts, or as an actual demonstration tool should be strongly considered.

Regardless of the device selected, it is hoped that additional investigation will continue. It was apparent to all who took part in the study that electronic image generation represents an exciting technology which can offer significant contributions to the graphic and photographic arts.



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